NO. BD1
DECEMBER 1956

JOURNAL of the

Board of Direction

PROCEEDINGS OF THE

AMERICAN SOCIETY OF CIVIL ENGINEERS

VOLUME 82

BASIC REQUIREMENTS FOR MANUSCRIPTS

This Journal represents an effort by the Society to deliver information to the reader with the greatest possible speed. To this end the material herein has none of the usual editing required in more formal publications.

Original papers and discussions of current papers should be submitted to the Manager of Technical Publications, ASCE. The final date on which a discussion should reach the Society is given as a footnote with each paper. Those who are planning to submit material will expedite the review and publication procedures by complying with the following basic requirements:

1. Titles should have a length not exceeding 50 characters and spaces.

2. A 50-word summary should accompany the paper.

3. The manuscript (a ribbon copy and two copies) should be double-spaced on one side of 8½-in. by 11-in. paper. Papers that were originally prepared for oral presentation must be rewritten into the third person before being submitted.

4. The author's full name, Society membership grade, and footnote reference stating present employment should appear on the first page of the paper.

5. Mathematics are reproduced directly from the copy that is submitted. Because of this, it is necessary that capital letters be drawn, in black ink, 3/16-in. high (with all other symbols and characters in the proportions dictated by standard drafting practice) and that no line of mathematics be longer than 6½-in. Ribbon copies of typed equations may be used but they will be proportionately smaller in the printed version.

6. Tables should be typed (ribbon copies) on one side of 8½-in. by 11-in. paper within a 6½-in. by 10½-in. invisible frame. Small tables should be grouped within this frame. Specific reference and explanation should be made in the text for each table.

7. Illustrations should be drawn in black ink on one side of 8½-in. by 11-in. paper within an invisible frame that measures 6½-in. by 10½-in.; the caption should also be included within the frame. Because illustrations will be reduced to 69% of the original size, the capital letters should be 3/16-in. high. Photographs should be submitted as glossy prints in a size that is less than 6½-in. by 10½-in. Explanations and descriptions should be made within the text for each illustration.

8. Papers should average about 12,000 words in length and should be no longer than 18,000 words. As an approximation, each full page of typed text, table, or illustration is the equivalent of 300 words.

Further information concerning the preparation of technical papers is contained in the "Technical Publications Handbook" which can be obtained from the Society.

This Journal is published by the American Society of Civil Engineers. Publication office is at 2500 South State Street, Ann Arbor, Michigan. Editorial and General Offices are at 33 West 39 Street, New York 18, New York. $4.00 of a member's dues are applied as a subscription to this Journal.

Journal of the

BOARD OF DIRECTION

Proceedings of the American Society of Civil Engineers

CONTENTS

December, 1956

Papers

Journal of the
BOARD OF DIRECTION
Proceedings of the American Society of Civil Engineers

CONTENTS

DISCUSSION
(Proc. Paper 1125)

Discussion of
"EDUCATION OF CIVIL ENGINEERS: NEED FOR RECONSIDERATION"

by L. E. Grinter
(Proc. Paper 858)

D. C. DRUCKER,[1] M. ASCE.—The 1955 report of the ASEE Committee on Evaluation of Engineering Education is a most encouraging portent of future progress of the engineering profession. Dean Grinter and the many members of the committee have done an excellent job indeed. The report and Dean Grinter's summary are clear and logical calls for radical changes in current practice in most of the engineering schools of the country.

It may be of considerable interest to members of the ASCE to know of the experience in the Division of Engineering at Brown University over the past eight years with almost exactly the type of curriculum proposed. This experience within the framework of a private University devoted primarily to the liberal arts is not necessarily directly applicable to all as such an environment is a particularly sympathetic one for this type of engineering program; each school must work out a suitable program for its students and staff.

An outline of the present curriculum will give an idea of its closeness to the 1955 ASEE-ECPD recommendations.

Sc.B. IN ENGINEERING CURRICULUM

Semester I	Semester II
Chemistry	Chemistry
Introduction to Engineering	Introduction to Engineering
English Composition or Elective	English Composition or Elective
Calculus	Calculus
Semester III	**Semester IV**
Vector Dynamics	Electricity and Magnetism
Differential Equations	Fluid Mechanics
Radiation Physics	Strength of Materials
Elective	Elective
Semester V	**Semester VI**
Electric Circuits	Electrical Machinery
Theory of Structures	Metallurgy and Physics of Solids
Thermodynamics	Thermodynamics
Elective	Elective

1. Prof., Div. of Eng., Brown Univ., Providence, R. I.

Semester VII	Semester VIII
Engineering Option	Engineering Option
Engineering Option	Engineering Option
Free Elective	Free Elective
Free Elective	Modern Physics

NOTE: Courses labelled ELECTIVE, as distinguished from FREE ELECTIVE, must not be chosen from the Physical Sciences group. A minimum of two must be selected in the Humanities and two in the Social Studies groups.

The first three years are common for all engineers; civil, electrical, mechanical, and aeronautical. This is a continuation of the policy established at Brown in 1920 and places the desired emphasis on science, mathematics, and engineering science as called for in the report. This emphasis obviously does permit, in the words of Dean Grinter, "considerably more than 'the common freshman year'". There are no service courses in engineering such as electrical engineering for civil engineers or structures for electrical engineers. Except in student chapter organizations there is no separation of students whatsoever in accordance with their probable choice for the senior year. All students therefore get the fundamentals of all fields as if they were to specialize in them later on. The same basic philosophy applies to the liberal arts courses taken by arts, science, or engineering students.

For those not familiar with a four course plan, it should be noted that each course is of equal weight and takes one quarter of the student's time each semester. Humanities and social studies thus occupy a prominent place in the program and may take up to 30 per cent of the total. Courses in accounting, engineering economy, etc. which, as Dean Grinter explains, are not liberal arts, may be taken as free electives only. ROTC combined with engineering requires 4 1/2 to 5 years instead of 4. A 5-year combined A.B. and Sc.B. program also is offered.

A bare recital of the courses cannot, of course, give a proper picture of the program. The curriculum is a very advanced one not alone in scope but also in content, a true professional education. A few examples may help to make this point clear. Vector algebra is studied in the freshman year to prepare the way for vector dynamics, fluid mechanics, electricity and magnetism in the sophomore year. The course in theory of structures treats the fundamental theorems of energy and of virtual work in their general form. Indeterminate and determinate elastic and elastic-plastic structures are considered. In all options, details of engineering design are postponed to the senior year along with advanced courses in theory. Again, fundamentals are emphasized so that, for example, both civil and aeronautical engineers take the same advanced course in theory of structures. The design courses are separate and involve introduction to design principles, not repeated practice in design. As Dean Grinter states: "The teaching of engineering art in college is synthetic and relatively unproductive except as it is used to illustrate and teach the principles of engineering science and design."

The call for "experimentation rather than standardization" cannot be seconded too strongly. All courses are re-examined continually and are changed year by year as the need for improvement is recognized. Adjustments are made among the courses to develop a more effective teaching and learning sequence with necessary but not wasteful repetition. Most

experimentation goes on in the Introduction to Engineering of the Freshman year, the most vital course in the engineering curriculum because it is the first. At present it includes elementary mechanics, college algebra, descriptive geometry, drawing, and vector algebra. It is tailored to the entering group of students and designed to bring them to a high level of college work as quickly as possible from a varied background smoothed only a little by a two-week pre-semester engineering orientation program.

Experience with the Brown curriculum has been most gratifying but must be interpreted carefully. Any change in curriculum will create at least as many problems initially as it solves. Eight years is not a long time and many questions are still unanswered. A large number of students entering as Sc.B. engineers leave with an A.B. just as they did years ago. It is extremely difficult for the student or the admissions officer to evaluate correctly both interest and ability in engineering at any level. Admissions problems are increased greatly by any appreciable change in program. Counseling of students requires considerably more time.

One of the major and unresolved difficulties, and one on which guidance is earnestly sought, is in the matter of student chapter activities and allied motivation. Because specialization is avoided so completely for the first three years most students do not think of themselves as civil engineers or electrical engineers, for example. Although this attitude may serve well the cause of unity of the profession in later years, interest in student chapters is not as strong as it should be. Activities tend to be marginal and sparsely attended. Here, the smallness of the group is a handicap. A fraction of the juniors plus all of the seniors in any one option do not add to a chapter of optimum size and provide the necessary continuity from year to year. A large school would not be as troubled by this feature. However, with a curriculum of this type, there is some tendency toward lack of drive on the part of a small but not negligible number of students. They will drift along through the first years and decide on their option on the basis of which is easiest for them rather than most interesting.

Certainly the performance of the students of each class still runs the spectrum from poor to excellent just as it does everywhere. The important difference is that now the students who are average or better are operating on a much higher and yet on a more fundamental level than ever before. Their ability to handle the diverse and difficult problems faced by engineers in research, design, construction, and management appears to be greatly enhanced but ten or so years must elapse before a real evaluation is possible. Surprisingly, perhaps, their ability to do the routine problems on which so little time is spent now is as good and often better than before. This point can be checked fairly well by test and classroom performance.

Much more remains to be done to develop curricula which meet the needs of the times or rather the needs of the future. The engineering science of today will seem as trivial or elementary tomorrow as the engineering science of yesterday seems now. More and more mathematics and science and improved laboratory science and technique must be incorporated in the engineering curriculum of the future. The tendency for specialization will become stronger and stronger as engineering becomes more complex and difficult. There is no conflict, however, between specialization in practice and fundamentals in education. Quite the contrary, high specialization will require an increasingly broader base of knowledge.

Engineering societies should encourage frequent evaluations of engineering

education in the hope that the productive results of Dean Grinter's committee can be developed and then extended in line with the needs and resources of each college and university.

L. E. GRINTER,[1] M. ASCE.—The discussion of Professor Drucker brings out one very important problem in relation to the future trends in engineering education. As he points out, the Brown University curriculum for the Bachelor of Science degree in engineering without designation as to field of study readily fulfils the definition of a scientific curriculum in engineering. A few institutions have been moving in this direction for several years. Others have joined them since the Committee on Evaluation of Engineering Education presented its preliminary report. Such rather drastic changes have been toward the establishment of new curricula entitled Engineering Science.

Although the Committee on Evaluation of Engineering Education would applaud such efforts as Dr. Drucker outlines, the Committee neither assumed nor took the position that there exists the necessity for such a revolutionary change in engineering education. Instead, the Committee pointed out its preference for evolution within the traditional framework of present departmental curricula toward a more scientific background for engineers. It remains the strong belief of the chairman and of all of the committee members who have re-expressed themselves during the past year that a more significant influence upon engineering education will be the gradual substitution of courses in engineering science and creative design for courses that presently emphasize art and knowhow in engineering. Particularly in civil engineering education, it is the evolutionary process of curriculum adjustment toward a more scientific viewpoint that is needed. There is encouraging evidence that such readjustments are receiving serious and favorable consideration.

1. Dean, Graduate School, and Director of Research, Univ. of Florida, Gainesville, Fla.

Discussion of "EDUCATION OF CIVIL ENGINEERS: TRAINING FOR CIVIL ENGINEERING"

by Benjamin A. Whisler
(Proc. Paper 859)

ALFRED R. GOLZE,[1] M. ASCE.—Mr. Whisler's discussion of his subject, from the viewpoint of an official in the Federal Government, is most interesting. It should be recommended reading for all civil engineering faculty members and by all members of the Society and the profession genuinely interested in having our college graduates enter the profession with an adequate educational background.

While it is probably true that there is more stability in civil engineering education than in those of the allied engineering arts and sciences, this should not develop a feeling of complacency on the part of the university authorities responsible for the curricula. Steady progress in the art of civil engineering is going on continuously and where this progress has produced a practice that is a part of the profession, it should be reflected in the curricula. For example, on graduation, a student should be aware that the civil engineer of today has new tools to aid him in doing a more effective job. Prestressing of concrete and welding of structures are examples. He should know too that the same basic principles of civil engineering which are applied to the design of small dams apply also to the design of the world's largest built in recent years. He needs to be exposed to the economics entering into modern superhighway locations and he should understand the importance of estimating construction costs as a basis for securing funds for the work. These items, selected at random, perhaps emphasize that civil engineering is necessarily more than can be acquired in the all too brief four years of college training that leads to a Bachelor's degree.

Experience with civil engineers in the Bureau of Reclamation, lead to the conclusion that whenever a student can devote an additional year for a Master's degree it is well worth doing. If the fifth year curricula includes those subjects designed to increase the breadth of his education, it will certainly make him a better employee after graduation, and increase his opportunities for positions of leadership in the engineering profession and related administrative fields in the years ahead. Also a fifth year could offer those students who have developed an aptitude for research development, an opportunity to develop that aptitude. We sometimes find men working on designs whose real interest is basic research and probably the reverse is true, too. A fifth year would help the potential graduate to select the occupational field for which he is best suited. With the attractive salaries now being offered a graduate, it may be difficult to interest students in a fifth year. The long-range value of a broader educational base is likely to be lost on the young man anxious to get started on his career. But anything the faculty members can do to interest fourth year bachelors to become fifth year masters will be of great service to the engineering profession.

Professor Whisler mentions the lack of training courses for civil engineers

1. Chief, Div. of Program Coordination and Finance, Bureau of Reclamation, U. S. Dept. of the Interior, Washington, D. C.

after graduation. The need for training by employers does need to be recognized. In some fields, such as electronics, in-service training is offered, and in effect may replace one or more years of graduate college work. A lot more could be done to establish training courses for graduate civil engineers, especially the Bachelors, with university participation so that degree credits towards a Masters could be given. The Bureau of Reclamation has worked closely with the universities from time to time in advancing the education of its engineering personnel. The Bureau also has on-the-job training as part of its personnel program for advancement of qualified employees. It is understood other Government agencies have similar programs.

New blood properly trained is essential to progress in any field. Civil engineering, a fundamental art and science of modern civilization, is no exception. Continuous constructive analysis, such as offered by Professor Whisler's paper, assures us that the universities are alert to their responsibilities.

BENJAMIN A. WHISLER,[1] M. ASCE.—As Mr. Golze points out, it may be that we have reached the point where a four-year curriculum leading to the bachelor's degree is no longer adequate for the education of the civil engineer. The schools are under increasing pressure to increase the basic scientific content as well as the non-technical content of the civil engineering curricula. These pressures have been resisted by those who recognize that education in these areas cannot be increased within the framework of the traditional four-year curriculum without sacrificing so much in the areas peculiar to civil engineering that the curriculum would no longer be a curriculum in civil engineering. Without question, the addition of another year to the undergraduate requirements would enable us to satisfy these pressures from outside civil engineering and at the same time to retain the identity of the civil engineering curriculum. A few institutions have recently made this change with apparent success and are satisfied with the results.

Within the present four-year curriculum one of the civil engineering teacher's greatest disappointments in recent years has been the increasing difficulty he has in convincing the better students that a year or more of graduate work would be well worth their while. Mr. Golze's statement concerning the value of the extra year of study is apparently held by many practicing engineers, but it is rarely seen in print. This statement will help the civil engineering educator when he is trying to encourage his better students to take graduate work.

PROCEEDINGS PAPERS

The technical papers published in the past year are identified by number below. Technical-division sponsorship is indicated by an abbreviation at the end of each Paper Number, the symbols referring to: Air Transport (AT), City Planning (CP), Construction (CO), Engineering Mechanics (EM), Highway (HW), Hydraulics (HY), Irrigation and Drainage (IR), Power (PO), Sanitary Engineering (SA), Soil Mechanics and Foundations (SM), Structural (ST), Surveying and Mapping (SU), and Waterways and Harbors (WW) divisions. Papers sponsored by the Board of Direction are identified by the symbols (BD). For titles and order coupons, refer to the appropriate issue of "Civil Engineering." Beginning with Volume 82 (January 1956) papers were published in Journals of the various Technical Divisions. To locate papers in the Journals, the symbols after the paper numbers are followed by a numeral designating the issue of a particular Journal in which the paper appeared. For example, Paper 861 is identified as 861 (SM1) which indicates that the paper is contained in issue 1 of the Journal of the Soil Mechanics and Foundations Division.

VOLUME 81 (1955)

DECEMBER: 842(SM), 843(SM)[c], 844(SU), 845(SU)[c], 846(SA), 847(SA), 848(SA)[c], 849(ST)[c], 850(ST), 851(ST), 852(ST), 853(ST), 854(CO), 855(CO), 856(CO)[c], 857(SU), 858(BD), 859(BD), 860(BD).

VOLUME 82 (1956)

JANUARY: 861(SM1), 862(SM1), 863(EM1), 864(SM1), 865(SM1), 866(SM1), 867(SM1), 868(HW1), 869(ST1), 870(EM1), 871(HW1), 872(HW1), 873(HW1), 874(HW1), 875(HW1), 876(EM1)[c], 877(HW1)[c], 878(ST1)[c].

FEBRUARY: 879(CP1), 880(HY1), 881(HY1)[c], 882(HY1), 883(HY1), 884(IR1), 885(SA1), 886(CP1), 887(SA1), 888(SA1), 889(SA1). 890(SA1), 891(SA1), 892(SA1), 893(CP1), 894(CP1), 895(PO1) 896(PO1), 897(PO1), 898(PO1), 899(PO1), 900(PO1), 901(PO1), 902(AT1)[c], 903(IR1)[c], 904(PO1)[c], 905(SA1)[c].

MARCH: 906(WW1), 907(WW1), 908(WW1), 909(WW1), 910(WW1), 911(WW1), 912(WW1), 913(WW1)[c], 914(ST2), 915(ST2), 916(ST2), 917(ST2), 918(ST2), 919(ST2), 920(ST2), 921(SU1), 922(SU1), 923(SU1), 924(ST2)[c].

APRIL: 925(WW2), 926(WW2), 927(WW2), 928(SA2), 929(SA2), 930(SA2), 931(SA2), 932(SA2)[c], 933(SM2), 934(SM2), 935(WW2), 936(WW2), 937(WW2), 938(WW2), 939(WW2), 940(SM2), 941(SM2), 942(SM2)[c], 943(EM2), 944(EM2), 945(EM2), 946(EM2)[c], 947(PO2), 948(PO2), 949(PO2), 950(PO2), 951(PO2), 952(PO2)[c], 953(HY2), 954(HY2), 955(HY2)[c], 956(HY2), 957(HY2), 958(SA2), 959(PO2), 960(PO2).

MAY: 961(IR2), 962(IR2), 963(CP2), 964(CP2), 965(WW3), 966(WW3), 967(WW3), 968(WW3), 969(WW3), 970(ST3), 971(ST3), 972(ST3)[c], 973(ST3), 974(ST3), 975(WW3), 976(WW3), 977(IR2), 978(AT2), 979(AT2), 980(AT2), 981(IR2), 982(IR2)[c], 983(HW2), 984(HW2), 985(HW2)[c], 986(ST3), 987(AT2), 988(CP2), 989(AT2).

JUNE: 990(PO3), 991(PO3), 992(PO3), 993(PO3), 994(PO3), 995(PO3), 996(PO3), 997(PO3), 998(SA3), 999(SA3), 1000(SA3), 1001(SA3), 1002(SA3), 1003(SA3)[c], 1004(HY3), 1005(HY3), 1006(HY3), 1007(HY3), 1008(HY3), 1009(HY3), 1010(HY3)[c], 1011(PO3)[c], 1012(SA3), 1013(SA3), 1014(SA3), 1015(HY3), 1016(SA3), 1017(PO3), 1018(PO3).

JULY: 1019(ST4), 1020(ST4), 1021(ST4), 1022(ST4), 1023(ST4), 1024(ST4)[c], 1025(SM3), 1026(SM3), 1027(SM3), 1028(SM3)[c], 1029(EM3), 1030(EM3), 1031(EM3), 1032(EM3), 1033(EM3)[c].

AUGUST: 1034(HY4), 1035(HY4), 1036(HY4), 1037(HY4), 1038(HY4), 1039(HY4), 1040(HY4), 1041(HY4)[c], 1042(PO4), 1043(PO4), 1044(PO4), 1045(PO4), 1046(PO4)[c], 1047(SA4), 1048(SA4)[c], 1049(SA4), 1050(SA4), 1051(SA4), 1052(HY4), 1053(SA4).

SEPTEMBER: 1054(ST5), 1055(ST5), 1056(ST5), 1057(ST5), 1058(ST5), 1059(WW4), 1060(WW4), 1061(WW4), 1062(WW4), 1063(WW4), 1064(SU2), 1065(SU2), 1066(SU2)[c], 1067(ST5)[c], 1068(WW4)[c], 1069(WW4).

OCTOBER: 1070(EM4), 1071(EM4), 1072(EM4), 1073(EM4), 1074(HW3), 1075(HW3), 1076(HW3), 1077(HY5), 1078(SA5), 1079(SM4), 1080(SM4), 1081(SM4), 1082(HY5), 1083(SA5), 1084(SA5), 1085(SA5), 1086(PO5), 1087(SA5), 1088(SA5), 1089(SA5), 1090(HW3), 1091(EM4)[c], 1092(HY5)[c], 1093(HW3)[c], 1094(PO5)[c], 1095(SM4)[c].

NOVEMBER: 1096(ST6), 1097(ST6), 1098(ST6), 1099(ST6), 1100(ST6), 1101(ST6), 1102(IR3), 1103(IR3), 1104(IR3), 1105(IR3), 1106(ST6), 1107(ST6), 1108(ST6), 1109(AT3), 1110(AT3)[c], 1111(IR3)[c], 1112(ST6)[c].

DECEMBER: 1113(HY6), 1114(HY6), 1115(SA6), 1116(SA6), 1117(SU3), 1118(SU3), 1119(WW5), 1120(WW5), 1121(WW5), 1122(WW5), 1123(WW5), 1124(WW5)[c], 1125(BD1)[c], 1126(SA6), 1127(SA6), 1128(WW5), 1129(SA6)[c], 1130(PO6)[c], 1131(HY6)[c], 1132(PO6), 1133(PO6), 1134(PO6), 1135(BD1).

---

c. Discussion of several papers, grouped by Divisions.

AMERICAN SOCIETY OF CIVIL ENGINEERS

OFFICERS FOR 1957

PRESIDENT

MASON GRAVES LOCKWOOD

VICE-PRESIDENTS

Term expires October, 1957:
FRANK A. MARSTON
GLENN W. HOLCOMB

Term expires October, 1958:
FRANCIS S. FRIEL
NORMAN R. MOORE

DIRECTORS

Term expires October, 1957:
JEWELL M. GARRELTS
FREDERICK H. PAULSON
GEORGE S. RICHARDSON
DON M. CORBETT
GRAHAM P. WILLOUGHBY
LAWRENCE A. ELSENER

Term expires October, 1958:
JOHN P. RILEY
CAREY H. BROWN
MASON C. PRICHARD
ROBERT H. SHERLOCK
R. ROBINSON ROWE
LOUIS E. RYDELL
CLARENCE L. ECKEL

Term expires October, 1959:
CLINTON D. HANOVER, Jr.
E. LELAND DURKEE
HOWARD F. PECKWORTH
FINLEY B. LAVERTY
WILLIAM J. HEDLEY
RANDLE B. ALEXANDER

PAST-PRESIDENTS

Members of the Board

WILLIAM R. GLIDDEN

ENOCH R. NEEDLES

EXECUTIVE SECRETARY
WILLIAM H. WISELY

TREASURER
CHARLES E. TROUT

ASSISTANT SECRETARY
E. L. CHANDLER

ASSISTANT TREASURER
CARLTON S. PROCTOR

PROCEEDINGS OF THE SOCIETY

HAROLD T. LARSEN
Manager of Technical Publications

PAUL A. PARISI
Editor of Technical Publications

COMMITTEE ON PUBLICATIONS

JEWELL M. GARRELTS, *Chairman*

HOWARD F. PECKWORTH, *Vice-Chairman*

E. LELAND DURKEE
MASON C. PRICHARD
R. ROBINSON ROWE
LOUIS E. RYDELL